Management of Quality in Computing Systems Education: *ISO 9000 Series Quality Standards Applied*

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Designers and implementers of courses for computing systems education who wish or need to incorporate quality systems will find little inspiration or assistance when they search the literature. While there is much debate about quality in education, there is not much which is of practical help for course designers, developers and implementers. Therefore, a general model which could facilitate the implementation of quality systems at a course level was developed by adapting Quality Systems concepts from industry.

The management of quality in manufacturing has always been an essential requirement for success. With the establishment of international and related national standards, quality management is progressing from an essential requirement to a contractual obligation. Advantages to both customer and supplier from compliance with these defined standards are clear. The customer can be confident in the ability of the supplier to deliver a product or service with a desired quality, and the supplier can focus on attaining and maintaining that desired quality at an optimum cost.

The principles of quality management are being extended into service industries, but what of one of the most strategic of service industries: education? Are standards of quality consistent with education? Indeed, what constitutes quality in education? Are the advantages for "customer" and "supplier" realizable in education, or is it simply too difficult to apply quality standards to such a diverse area?

This debate has been carried on for some years, and is likely to continue for some considerable period in the future. However, there is an immediate and critical necessity for assistance to designers and developers of courses who wish, or need, to build quality systems into their courses.

A general model to facilitate the implementation of quality systems at a course level has been developed in a new distance education institution responsible for the rapid development of numbers of degree level courses.

The first part of this article focuses on the development of a specification of educational quality elements and processes based on the International Standards Organization 9000 model. The second part deals with the application of this quality specification to the Business Information Systems courses at the Open Learning Institute of Hong Kong, showing what has been achieved, what remains to be achieved and drawing some conclusions about the model.

PART A
Why Bother with Quality?

Quality issues have become increasingly important in recent years in many different types of organizations. The major motivation for this interest in quality seems to be a reduction in the number and value of resources available to organizations. While resources have been diminishing, management has become accountable for deriving the greatest benefit from these limited resources. The recent focus on the quality of goods produced and services provided by an organization has been a direct outcome.

This trend of diminishing resources is seen frequently in organizations receiving government funding, and is particularly noticeable in educational institutions.

What is Quality?

The initial reaction from many people faced with this question is, that it is difficult to say! Quality means different things to different people and it also depends on the time and the place. Simple definitions such as "fitness for purpose" do not seem to capture the complete concept.

Quality Scale

If there have been difficulties in the definition of quality, there is much less difficulty in the ranking of products on a quality scale.

Parry's Quality Scale (1973) provides a complete spectrum from "miraculous" to "catastrophic":
> *Miraculous, fantastic, amazing, outstanding, exceptional, excellent, very good, good, acceptable, fair, troublesome, poor, extremely,*

poor, non-existent, shocking, terrible, hopeless, disastrous, catastrophic.

Quality Standards

In 1986, the International Standards (ISO) attempted to rationalize the range of opinions on quality issues by releasing its first Quality Standard. ISO started by screening existing publications to determine the terms used in quality discourse and then produced a standard set of definitions. This standard, *ISO 8402-1986 on Quality-Vocabulary*, was the first of a series of standards which now include:

ISO 9000 - Quality management and quality
             assurance standards

             Guidelines for selection and use

ISO 9001- Quality systems model (quality as-
             surance in design/development, pro-
             duction, installation and servicing)

ISO 9002- Quality systems model (quality as-
             surance in production and installation)

ISO 9003- Quality systems model (quality as-
             surance in final inspection and testing)

ISO 9004- Quality management and quality
             system elements

             Guidelines

Note: The ANSI / IEEE standards are compatible with these ISO standards. While these quality models were primarily prepared for manufacturing processes, the disciplines involved are relevant to other processes. A revised quality model directed at service industries, (including education), is currently nearing completion. This new standard is known as ISO 9004.2 DIS, (Draft International Standard), and has been used in the preparation of this paper.

Definitions

The definitions following are taken from the 1986 ISO Standard 8402.

Quality: The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

The standard further notes that:
• In a contractual environment, needs are specified, whereas in other environments, implied needs should be identified and defined.

• In many instances, needs change with time; this implies periodic revision of specifications.

• Needs may include aspects of usability, safety, availability, reliability, maintainability, economics and environment.

• The term "quality" is not used to express a degree of excellence in a comparative sense nor is it used in a quantitative sense for technical evaluations. In these cases a qualifying adjective should be used e.g. "relative quality" or "quality measure".

• In some reference sources, quality is referred to as " fitness for use" or "fitness for purpose" or "customer satisfaction;" but that these represent only facets of quality.

Quality Loop or Quality Spiral: Conceptual models of interacting activities that influence the quality of a product or service in the various stages ranging from identification of needs to the assessment of whether these needs have been satisfied.

Quality Management: That aspect of the overall management function that determines and implements the quality policy.

Quality Assurance: All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. (The requirements must fully reflect the needs of the user; QA usually requires a continuing evaluation of factors; QA serves as a management tool.)

Quality Control: The operational techniques and activities that are used to fulfill requirements for quality. (Includes both monitoring a process and eliminating causes of unsatisfactory performance.)

Quality System: The organizational structure, responsibilities, procedures, processes and resources for implementing quality management.

Quality System

As stated simply in ISO 9004, the primary concern of any organization must be the quality of its products and services. The objectives of a successful organization must be to provide products and services that:

• Meet well defined needs

• Satisfy their customers' expectations

• Comply with applicable standards & specifications

• Comply with statutory (and other) requirements of society

• Are made available - at competitive prices

• Are provided at a cost to realize financial targets

To meet these objectives, the organization should organize itself to ensure that the technical, administrative and human factors which affect the quality of its products and services can be controlled.

This can be achieved through the development and implementation of a quality system. A quality system has four major components: management, resources, systems and procedures and customer interactions. The management of quality is a complex task which requires the integration of each of these four major components.

Management has the responsibility to develop, state and implement an organization-wide policy on quality. An appropriate level of resources to enable achievement of the quality policy are to be committed. Operational systems and procedures in support of the policy are to be designed, documented and properly implemented.

Figure 1 shows that the customer is the focal point of the quality system. It also shows that customer satisfaction is assured only when management responsibility, personnel and resources and the quality system structure are all properly focused and integrated.
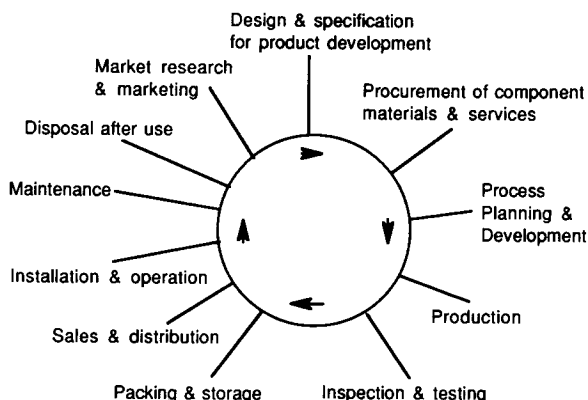
Fig. 1: Relationship Between Quality System Components

Management Responsibility
Customer Interactions
Quality Systems Structure
Personnel & Resources
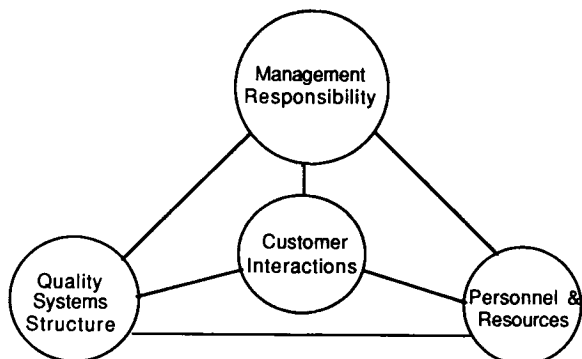
Quality Loop

The Quality Loop in Figure 2 shows how all the elements in a quality system structure interact. This Quality Loop was developed for manufacturing.

Fig. 2: Interaction of Elements in a Quality Loop

Design & specification for product development
Market research & marketing
Procurement of component materials & services
Disposal after use
Maintenance
Process Planning & Development
Installation & operation
Sales & distribution
Production
Packing & storage
Inspection & testing

QUALITY IN EDUCATION
Introduction

While quality has been considered historically to be a subjective state, subjective judgement has been officially accepted as the determinant of quality in education. This acceptance of subjectivity has been a problem, and not only for educators.

In 1964, the UK government established the Council for National Academic Awards (CNAA). The CNAA was charged with the task of 'quality control' in the public sector of higher education. In 1976 a list of quality elements in higher education was prepared by the CNAA. As recounted by Silver, these elements included the quality of:

    those who teach;

    those who plan courses;

    those who are admitted to courses of study;

    those who assess and examine;

    the academic environment; and

    the physical environment.

The CNAA itself emphasized that only the last element was amenable to other than subjective judgement. This raised questions as to whether or not subjective judgement was satisfactory, and, if it was not, then who should be responsible for defining the measures of quality?

In his history of the CNAA, Silver observes that while 'standards' and 'quality' had been the heart of the CNAA's concerns, neither it nor other organizations which provided or were concerned with higher education had been eager to define or to debate the concepts too closely.

By 1984 it was realized that more precision was essential. The UK National Advisory Board for Local Authority Higher Education (NAB) addressed the question directly in a paper which acknowledged it had been making judgements about quality but, "it has not defined, nor stated explicitly, what quality is, or consists of." The Chairman of the NAB extended the debate with a paper entitled, "What the hell is quality?"

An Educational Quality Scale

Based on Parry's Quality Scale, which was developed to illustrate the ranges of quality, an Educational Quality Scale (see Figure 3) can be developed. This Educational Quality Scale considers current resourcing implications and the possible long term educational consequences of achieving various levels of quality.

Applicability of Quality Standards

Quality standards can be seen to be very applicable to education, although some modification is required. These modifications must recognize the specialized service nature of education. It must also be recognized that there is a reluctance in some academics to consider the educational processes as well as the subject content requirements of a course.

An Educational Quality Model

This model comprises a Educational Quality Loop which illustrates interaction between the Quality Loop elements, (see Figure 4) and a detailed list of the activities comprising each element. This model has been developed from ISO 9004.2.

Activities Comprising Educational Quality Loop Element

The following list represents the major activities for each Quality Loop Element, at a summary level only. Each activity is made up of numerous tasks. The activities are particularly representative of Distance Education processes.

Fig. 3: Educational Quality Scale

Current resourcing implications	Quality Scale	Possible long term consequences
Costly	Miraculous fantastic amazing outstanding exceptional	Increasing commitment to and specialisation on a few discipline areas with general neglect.
Optimum	excellent very good good acceptable	Balanced curricula across faculties.
Cheap	fair troublesome poor	General demise of faculties.
Bankruptcy	extremely poor non-existent shocking terrible hopeless disastrous catastrophic	Banana Republic status.

Market Research
• Determine client needs

• Determine specific requirements

• Communicate needs and requirements with the organization

• On-going evaluation of needs and requirements

Design specification
• Translate client needs/requirements into specification for programs/courses

• Define project, time frame & allocate responsibility

• Define performance target values

• Periodic review and evaluation of design

• Design change control procedures

Course Planning
• Define in detail requirements for each course

• Research availability of courses to meet needs

• Determine costs of revision for local requirements (if any)

• Determine 'build' or 'buy' options within course budgets

Development
• Define additional development requirements, e.g., specification of formats, development/payment stages

• Select qualified developers (RFI, Tender bids, contracts, etc.)

• Develop course design (Blueprint)

• Control through periodic evaluation & review

• Allocate responsibility to institute corrective action
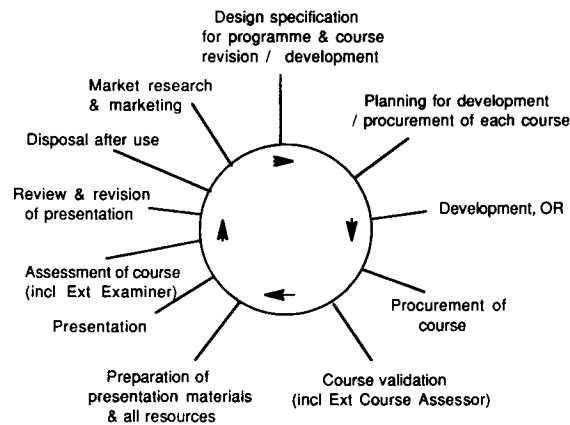
Procurement
Define procurement requirements, e.g., payment formulas

• Select qualified suppliers (including contracts and agreement on QA for course)

• Control through evaluation of courses

• Allocate responsibility for instituting corrective action

Course Validation
• Select and appoint external course assessor

• Ensure course requirements have been met

• Proper collection, maintenance and access to project documentation

Preparation of Presentation Materials and Resources
• Produce & store study materials

• Advice to publishers of numbers of texts required

• Prepare facilities for tutorials, (accommodation, equipment and other resources)

• Select, employ & train tutors and other staff

• Advertise course details

Presentation
• Process student applications

• Allocate tutorial groups & locations

• Distribute course materials

• On-going tutor training

• Inspect tutorials

Fig. 4: Interaction of Elements in Educational Quality Loop

Design specification
for programme & course
revision / development

Market research
& marketing

Planning for development
/ procurement of each course

Disposal after use

Review & revision
of presentation

Development, OR

Assessment of course
(incl Ext Examiner)

Procurement of
course

Presentation

Preparation of
presentation materials
& all resources

Course validation
(incl Ext Course Assessor)

Assessment
• Monitor formative & summative assessment by internal & external examiners

• Standardize scriptmarking

• Review of course results - by School and Institute

Review and Revision
• Feedback on course & assessment by tutors, scriptmarkers, internal & external examiners & course co-ordinators

- Student assessment and feedback
- Revisions to course
- Validation of revisions

Disposal after Use
- Following change management guidelines to dispose of courses which cannot be satisfactorily revised to meet changing requirements

PART B
Application of the Educational Quality Model to BIS Courses at OLI: The Environment
Hong Kong is a British-governed overseas territory. It has a population of approximately six million. Tertiary education is experiencing substantial growth in the Territory. In the three financial years 1987 to 1990, there was a 40% growth in funding by the government. This funding was in addition to the $HK 1.5 billion, ($US 190 million), donated by the Royal Hong Kong Jockey Club for the establishment of the University of Science and Technology.

There are eight government funded degree granting tertiary institutions: three universities (including the UST), four polytechnics/colleges, and a distance education provider, the Open Learning Institute of Hong Kong (OLI).

The OLI
The OLI's mission is to provide degree, non-degree and post graduate courses through a system of open access and distance education, regardless of previous qualification, gender or race. The Institute has committed itself to excellence in teaching, scholarship and public service, and is further committed to achieving financial self-sufficiency, in time, without sacrificing the level and quality of courses and support for its students.

The OLI was established in June 1989. The first degree programs advertised were BA (Western Arts), BBA, and BSc. There were 60,000 applications for the first 4,000 positions. The first students commenced in October 1989 enrolled in eight courses. By October 1991, the numbers of students had risen to nearly 20,000 with enrollments in 29 courses.

Computing courses are available in two schools: computer science oriented courses, (including electronics), in the School of Science and Technology, and business oriented courses in the School of Business and Administration. Business Information Systems courses are offered only by the School of Business and Administration in the BBA program.

The BBA Program and BIS Courses
The aim of the BBA degree program is:

"...to provide students with practical skills and intellectual depth to be effective and efficient managers in private and public enterprises in Hong Kong. The programs are also structured to meet the requirements of the various professional bodies in each of the disciplines... Accounting, Human Resource Management, Marketing, Business Information Systems."

Business Information Systems (BIS)
The aim of the Business Information Systems stream is to develop in students the capability to successfully apply and manage technology solutions to critical business and organizational problems.

Objective in the Development of the BIS Stream
To set and to achieve the highest standard in professional, practical and industry responsive business information systems education in order to enhance the capability and productivity of Hong Kong.

Clients of the BIS Stream
- Organizations or departments of organizations which have a responsibility to provide a professional computing and/or information systems service

- Designers, developers, manufacturers and suppliers of information technology goods and services

- Consultants & advisors to business in the fields of effective and efficient use of data, information and associated technology

- Our students

- The government of Hong Kong

Client Objectives
- To make a significant contribution to overcoming the critical shortage of qualified people available to Hong Kong's industries

- To identify our clients vocational and personal requirements through effective market research

- To determine a priority for meeting those client requirements

- To provide a means which will enable students from all backgrounds to further develop and to realize their potential

- To assist people to choose, from the outset, the course of study appropriate to their current potential and appropriate to their interests and motivation

- To establish and to maintain the highest level of confidence in our courses from Government, Industry and the Community

Themes within the BIS Stream
1. Each of the seven courses in the BIS stream is to be relevant, practical, interesting to the student and progressively applicable in their own right
2. Each course is to embody and develop professional and ethical attitudes in the students
3. Each course is to contribute to the development of the student's logical reasoning abilities, and their disciplined approach to problem solving

4. Each course will utilize the technology to teach the technology, to the fullest extent consistent with quality and effective education

BIS Stream Courses in BBA Pass Degree
1. Systems Analysis & Design

2. Advances in Information Technology

3. Networking Applications

BIS Stream Courses in BBA (Hons)
4. Application Systems Management

5. Information Systems Strategic Planning

6. Information Systems Strategic Implementation

7. Information Systems Project

Notes:
1. The IS Project is a research project into applications of IT for local industry in Hong Kong.

2. Each course runs over 40 weeks.

3. The average student is expected to devote about 300-350 hours to each course. This includes preparation, study time, tutorials, and assignments.

Quality Assurance and Quality Control in BIS Courses
These are the major activities for each Educational Quality Loop Element, and are listed at a summary level only (See Figure 6, Parts A & B on pages 41 and 42). Each activity is made up of numerous tasks. The activities are particularly representative of Distance Education processes.

Quality Issues Not Addressed
Very few quality activities at a course level are not explicitly catered for by the OLI .

Adherence to quality is mentioned specifically in the OLI's Mission Statement, so there is an obvious acceptance of quality as an underlying factor in the operation of the OLI.

However, the establishment of primary goals, quality objectives and the specific allocation of responsibility and authority for quality activities is missing. Senior management need to provide for periodic formal and independent reviews of the Quality System to determine the continuing suitability and effectiveness in implementing the quality policy and achieving the quality objectives.

This recognition of the importance of the issue, but lack of formal and specific policy on quality by senior management, is apparently a situation faced by many organizations.

Conclusions
The Quality Standards of the ISO 9000 series have been found to be applicable, with some modifications, to education. Based on ISO Standard 9004.2 (DIS), a model has been developed to provide a guideline for course developers/implementors in the design and implementation of quality systems.

This model has been applied to the Quality Systems developed for Business Information Systems courses at the Open Learning Institute of Hong Kong. It has been seen to be effective for BIS courses in the context of OLI.

The context of OLI has been an important factor in the development of these Quality Systems. This is due to its status as a new institution. Experienced staff faced with the necessity of developing large numbers of courses and programs have not been limited by existing practices or procedures. Also, as a new institution, the OLI has had reason to be proactive in the development of quality systems in order to facilitate international recognition of its courses and programs.

Business Information Systems courses have an advantage of being in an area of recognized and substantial skill shortage. Consequently, much survey material is available for the market research activities of course development. It is accepted that market research activities would be more difficult for

Figure 5: Areas of Student Competency to be Developed in the BIS Stream of BBA and BBA (Hons)

Types of technology	Methodologies and skills required to utilise the technologies	Application of the technologies and methodologies.
What they are. How they work	What they are. How they work	Includes what Organisation-wide methodologies there are & how they work.
Ability to utilise (hands on)	Ability to utilise (hands on)	Ability to apply - includes case studies of successful and un-successful applications. (With a HK / Asian emphasis)
How to find out about emerging tools and technologies	How to find out about emerging methodologies and skill sets.	Includes a major project which will integrate the three areas of competency.
eg 4GL, CASE, DBMS, Networking, Distributed DBMS, EDI, Expert Systems	eg Systems Analysis & Design (includes Ergonomics & Man: Machine Interface), SDLC, Information Mgmt (incl Records Mgmt), Project Mgmt, IT Mgmt, Controls, Security, EDP Audit, Software / Hardware Evaluation & Selection, End User computing, Effective Systems Documentation (Technical Writing)	eg Organisational Analysis (How a business works), Strategic Planning, IT Strategic Planning Systems Selection & Implementation Planning, Change Mgmt, Applications of technology (eg Office Technology, Airline / Banking / Manufacturing / Trading Systems), Technology and society,
Emphasise Professional Ethics for the IT Industry	Emphasise Professional Ethics for the IT Industry	Emphasise Professional Ethics for the IT Industry

courses lacking a clear career orientation, or not having access to appropriate survey material for any other reason.

However, it is felt that neither the status of the OLI as a new institution, nor any particular orientation of the BIS courses render this model unsuitable for use in other courses or institutions.

Finally, based on the OLI experience it must be emphasized that the development and implementation of a quality system is a highly complex task. It cannot be accomplished by an individual or isolated course developer. An organization should not undertake such a task lightly. However, if management is strongly inclined towards, or strongly coerced into,

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Figure 6: OLI's QA and QC Activities Compared with Model - Part A

Model's activities	OLI's	Comments on OLI's activities
Market Research		
• determine client needs;	√	PCOLI determined programmes & streams
• determine specific requirements;	√	Market research by BIS staff, APG
• communicate needs and requirements within org.;	√	BIS, School, Academic Board
• on-going evaluation of needs and requirements;	√	Market research by BIS staff
Design specification		
• translates client needs / requirements into specification for programmes / courses;	√	BIS, School, APG, AB, Council
• define project, timing, and allocate responsibilities;	√	BIS, School
• define performance target values;	√	OLI has objective of being self-supporting
• periodic review and evaluation of design;	√	Proj Mgr,ETC,School,AD(A),Circ.
• design change control procedures;	√	BIS, School, ECA, AB
Course Planning		
• detailed definition of requirements for each course;	√	BIS
• research into the availability of suitable courses;	√	BIS
• calculate costs of revision for local requirements;	√	BIS, ETC, School
• decide 'build' or 'buy' options within course budgets;	√	BIS, School, AD(A)
Development		
• definition of additional development requirements, eg spec. of formats, development/payment stages;	√	BIS, School, ETC
• select qualified developers (RFI, Tender, contracts)	√	BIS,School,ETC,Suppl,Tender Bd,AD(Adm)
• develop course design (Blueprint);	√	BIS, ETC, School,
• control through periodic evaluation & review;	√	BIS, ETC, School
• allocate responsibility for corrective action;	√	School, ETC, AD(A)
Procurement		
• definition of procurement requirements;	√	BIS, ETC, ADs, payment formula/schedule
• selection of qualified suppliers (including contracts and agreement on QA for course);	√	BIS, School, ETC, ADs
• control through evaluation of courses;	√	BIS, School, ETC, ECA
• allocate responsibility for corrective action;	√	School, ETC, AD(A)
Course Validation		
• select and appoint external course assessor;	√	BIS, School, AB, Council
• ensure course requirements have been met;	√	BIS, ECA, School, AB, Council
• proper collection, maintenance and access of and to project documentation;	X	Not formally collected/ centrally managed (individual units hold own records)

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the setting and achieving of standards for quality performance, then there are substantial benefits for the institution, the courses, and most importantly, for the students. ● ● ●

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Figure 6: OLI's QA and QC Activities Compared with Model - Part B

Model's activities	OLI's	Comments on OLI's activities
Preparation of presentation materials and resources		
• production & storage of study materials;	√	ETC, Publishing/Warehousing Dept
• advice to publishers of numbers of texts required;	√	School, Publishing/Warehousing Dept
• preparation of facilities for tutorials, (accommodation, equipment and other resources);	√	BIS, Supplies, Building & Equip Dept
• select, employ & train tutors & other staff;	√	Personnel, BIS, School, ETC
• advertising course details;	√	School, Registry
Presentation		
• processing student applications;	√	Registry
• allocation to tutorial groups & locations;	√	Registry
• distribution of course materials;	√	Publishing/Warehousing Dept
• on-going tutor training;	√	BIS, ETC
• inspection of tutorials;	√	BIS
Assessment		
• monitoring of formative & summative assessment by internal & external examiners;	√	BIS, Ext Examiner, CRC, AB, Council
• standardisation of script marking;	√	BIS, Registry
• review of course results - by School and Institute;	√	BIS, School, CRC, AB, Council
Review and revision		
• feedback on course & assessment by tutors, scriptmarkers, internal & external examiners, & course co-ordinators;	√	BIS, AB
• student assessment	√	BIS, ETC student surveys (incl dropouts)
• revisions to course;	√	BIS, School
• validatation of revisions;	√	BIS, School, ECA, AB
Disposal after use		
• follow change management guidelines to dispose of courses which cannot be satisfactorily revised to meet changing requirements;	X	No formal mechanism as OLI is so new.

Abbreviations

AB - Academic Board
ADs - Associate Directors responsible for Divisions
BIS - staff of Business Information Systems stream in BBA
Circ. - circulation incl Publishing,Registry,Resources Division
ETC - Educational Technology Centre (incl Course Designers)
School - School of Business & Administration

AD(A) - Associate Director (Academic)
APG - Advisory Peer Group
CRC - Course Results Committee
Council - Council of the OLI
ECA - External Course Assessor
PCOLI - Planning C'tee setting up OLI